

ford Oil Sand of McKean county, Pennsylvania. Remarks were made by Dr. Rogers and Mr. Lesley.

Prof. Frazer exhibited his microscopic reflector, made by Mr. Zentmeyer.

Mr. Frazer then discussed the principles of the problem of the popular 15 number puzzle with Mr. Briggs.

Pending nominations Nos. 893 to 897, and new nominations Nos. 898 to 901 were read.

On motion, the subject (postponed from the last meeting) of appointing delegates to assist at the Centennial Anniversary of the American Academy of Science and Art, at Boston, was referred to the President, Mr. Fraley, with power to act.

And the meeting was adjourned.

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*On the Constitution of the Bradford Oil Sand. By Chas. A. Ashburner, M.S., Asst. Second Geological Survey of Pennsylvania. (With a plate.)*

(Read before the American Philosophical Society, March 5, 1880.)

The constitution of the petroleum sands of Western Pennsylvania, which were discovered in Venango county twenty-one years ago, and which have ever since been producing mineral oil, is no doubt familiar to most of our geologists. The question suggests itself; in what way is the Bradford sand of McKean county, Pennsylvania, and Cattaraugus county, New York, dissimilar?

Before describing the structure of the sands, permit me to give some general facts showing the relative per centage of *dry holes* and the out-put of the *producing wells* in the two districts. At a glance, the comparison will indicate that some essential differences must exist in the sands and mode of occurrence of the oil, to account for the different results which have been obtained.

During the year 1879, there were 475 wells drilled to the Venango oil

sands in the counties of Warren, Venango, Clarion and Butler; of this number 122 were *dry holes* or produced no oil; being 25.7 per cent.

In the Bradford or Northern district, there were during the same year, 2536 wells drilled to the Bradford oil sand, of which number but 76 were *dry holes* or only 3 per cent.; being nearly 23 per cent. less than in the Venango or Western district.

The average daily production, for the first month, of the wells drilled in the Bradford sand was about 20 barrels, while for the wells in the Venango sands it did not attain that amount.\* When we take these facts into consideration, we can readily understand why there should have been 2536 wells drilled in the Northern district to only 475 in the Western.

Since the beginning of the year 1875, when the Bradford oil horizon was discovered, there have been 6249 wells drilled in the district, of which 236 were dry holes or 3.77 per cent. From the most authentic statistics which I can gather in the Western district, about one-fourth of all the wells which have been drilled in the Venango sands, since their discovery in 1859, have proved dry.

The Bradford sand consists of a gray and white sand, of about the same coarseness as the ordinary beach sand of the Jersey coast; compact, yet loosely cemented. The average thickness of the sand is about 45 feet, and from top to bottom, the sandy strata change but little in their general character. It is only when specimens from the successive layers are placed side by side and closely examined, that any difference in structure can be recognized. The grains of sand are angular, vary but slightly in size, color and the quantity of cementing material which holds them together in their rock bed.

The same homogeneousness, which characterizes the vertical section, is found to exist over a considerable horizontal area. In fact but little change is found to exist in the sand obtained from wells 15 miles apart, or in the sand from the intermediate wells.

The greatest length of the Bradford district is 18 miles north, 30° east; its greatest width is 12 miles in a north and south direction. The area of the territory is between 100 and 110 square miles. In this area the sand is so regular and constant that if wells were drilled at random the number of dry holes, which would be obtained, would hardly exceed 2 in every 100. The percentage of dry holes spoken of as being obtained in the district includes those which were drilled outside of the *probable oil territory* and were genuine *wild-cat wells*.

In the Western district the characteristics of the Venango sands are quite different. The third or bottom sand, which is the most productive of the

\* Some of the wells drilled to the Venango third oil sand have produced from 2000 to 3000 barrels of oil per day, while the largest well ever found in the Bradford district has not exceeded as many hundred. The largest individual wells have been located in the Western district; the largest average wells in the Northern district.

group, is sometimes thin, very fine, micaceous and muddy when taken from the sand pump; in this condition it seldom produces any petroleum. This is the character of the sand at Pleasantville, where it contained only a trace of oil. The black oil of this district came from what was known as the stray or split third, occurring some 25 feet above the regular sand. Where the Venango sands are formed in thin layers, fine grained and clayey the driller views the territory with suspicion.

NOTE.—It must be remembered in comparing the sands of the two districts that they belong to different geologic formations. Based on lithological and stratigraphical facts, I make the Venango oil sand group the equivalent of the Red Catskill, No. IX (Old Red Sandstone), while the Bradford sand is of Chemung age.

The following general section shows their relative positions :

Venango group, Catskill, No. IX.	{	First sand.....	40 feet.
		Interval.....	105 "
		Second sand.....	25 "
		Interval.....	110 "
		Third sand.....	35 "
Chemung, No. VIII.	{	Interval.....	1000±
		Bradford sand.....	45' "

See "Oil Sands of Penna.," Franklin Institute Journal, April 1878, also "Bradford Oil District," Transactions American Institute Mining Engineers, Vol. VII; by the Author.

The accompanying illustration shows a typical specimen of a good producing third sand in the Venango group and a specimen of Bradford sand, such as might be taken from any of the producing wells in the Northern district. A productive Venango sand consists of a white, gray or yellow pebble rock; the pebbles being loosely cemented together and generally bedded in fine sand. The rock is open and porous. The interstices between the pebbles and sand grains are extensive and capable of containing a large bulk of oil; but this character does not maintain itself over any extended area. Areas of such sand are small and scattered and are separated by sand beds, possessing a character belonging to the unproductive sands.

The Venango sands are not homogeneous over any considerable area and are frequently very heterogeneous in section. The thickness of the sand varies; in one locality the upper part of the sand may be pebbly and of productive character and the lower part fine and contain no oil, while but a short distance away the conditions may be reversed.

Such then are the principal features of the two great oil producing rocks of Pennsylvania.

*Résumé.* The Bradford sand is fine but porous; constant in thickness; homogeneous in section; the character of the sections remaining the same over a very wide area.

The Venango sands are sometimes coarse, pebbly and porous, and sometimes fine, compact and clayey; variable in thickness; heterogeneous in section and subject to sudden changes in very short distances.

The difference in the structure of the sands, when considered in connection with their relative productiveness, is a strong argument in support of the view which has been accepted by the *best informed* of our geologists that the sands are only reservoirs or sponges which serve to hold the oil, coming almost entirely from an inferior formation to which it is indigenous.

The conditions under which these two sands were deposited must have been essentially different. The Venango sands were undoubtedly shore and shallow water deposits. The currents, by which the sediments forming the group were transported, were evidently rapid and shifting. It has been suggested that the sands may have been laid down in a river bed. This would necessitate dry land at the time, on either side of the territory where the sands are at present found.

The Bradford sand was possibly deposited in deeper water, by a slower and more constant current. It does not bear any evidences of being a shore deposit, but was probably formed in a bay or estuary.

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*An Obituary Notice of the Late John W. Harden. By J. P. Lesley.*

(*Read before the American Philosophical Society, March 5, 1880.*)

John W. Harden was born at Leicester, England, June 19th, 1816, and died at Philadelphia, November 8th, 1879.

He was versed in the arts of Horticulture and Floriculture, and for a number of years followed them professionally. Was especially successful in designing, ornamenting and laying out estates, notably those of Hon. Capt. Cust. Wormleybury, Hertfordshire and Sir Ralph Howard, Bart., Craven Cottage on the Thames.

He commenced practice as a Mining Engineer in 1846, and in that year took the management of the Hawkesbury Colliery, near Coventry, England. He was the means of introducing into the Warwickshire coal field most of the modern improvements at that time only in use at the best collieries in the North of England. Wire ropes took the place of hemp ropes